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# Conservation Actions in a Small Sea Turtle Feeding Area at Phra Thong Island, Thailand.

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***ABSTRACT***
This study has been conducted as part of the Sea Turtle Conservation Project (STCP) at Phra Thong island (PTI), South Thailand, which has focused on sea turtle research and conservation since 1996. An area of about 40 $m^2$ in the sea was identified and used as a study area to collect data on sea turtle behavior. Every turtle nesting season (January to April), juveniles of hawksbill turtle (*E.imbricata*) and green turtle (*C.mydas*) were regularly observed. The number of sightings from 2006 to 2011 varied from 8 to 128. The highest number of sightings (N=128) was recorded in 2010, when a hawksbill turtle (juvenile) was observed in the area within the same space nearly everyday. Those sightings were also noted as the longest diving time (15.4 to 17.3 minutes on average) compared with other years. The data collected confirmed the importance of this area as a sea turtle feeding ground. The area is also used by local fishermen, by touristsvisiting for snorkeling trips and more recently by divers. The human impact is increasing year by year, threatening one of the remaining areas suitable for sea turtle feeding ground.

**KEYWORDS: sea turtles, Thailand, feeding ground**

**INTRODUCTION**

The STCP began in 1996 in collaboration with the Phuket Marine Biological Center on PTI (Phang-Nga province, South of Thailand). The nesting species on the island are: green turtle (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*) and leatherback (*Dermochelys coriacea*); one further species is found swimming: the hawksbill turtle (*Eretmochelys imbricata*).

The observation site, named “Hornbill Hill” (09°07.577N 098°14.981E), consists of a small rocky hill 16 m high in the Andaman Sea, on the West coast of the island. The study area delineated in the sea has a mixed rocky and sandy substrate, and is used by fishermen and tourists. The presence of sea turtles was investigated from 2007 to 2011. Between December and April each year observations were regularly conducted. Results and considerations are summarized providing a first evaluation of the importance of this area, which should be declared a Marine Protected Area (MPA).

**MATERIALS AND METHODS**

The study area was identified by a central buoy (B5) (Fig. 1). A grid divided into 16 sectors of 10m2 each was created. The rocks underwater were used to locate the grid and to facilitate the observer. The grid is used as a tool to locate and record the emergences of the sea turtles.

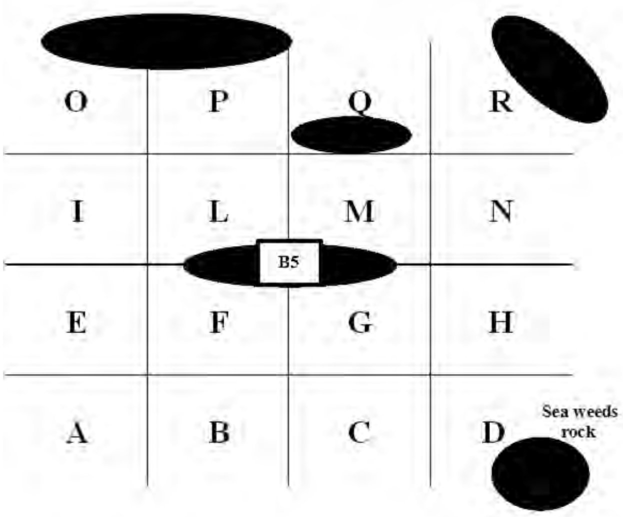


Fig. 1: This scheme represents the virtual grid of the study area. The central buoy, B5, was placed over an underwater rock. Black circles represent underwater rocks.

Two hours of observations (in the morning and in the afternoon) were regularly conducted by at least two trained volunteers.The number of sightings was recorded as the number of days observed, specifying whether the sighting occurred in the morning or afternoon.

For each turtle sighting the species, general behavior (swimming, breathing, feeding or basking), time (in minutes) of the emergence of the head and location within the grid were recorded. The species occurrence was affected by the ability of the observer to identify the species and therefore cannot be considered as confirmed data in all cases. Emergence is when a sea turtle is seen on the surface with its head out of the water to breath or in a different behavior such as swimming or basking. The diving time (how much time the turtle spends underwater) was recorded as the number of minutes that passed between each emergence. The average diving time was calculated (mean = total diving time in minutes/how many times it emerged).

The study area was surveyed under water following4 linear transects parallel to the coast in 2007, 2008 and 2009. Transects were designed according to reef check methodology (Reefcheck Website: http://www.reefcheck.org). The depth of the study area varies from 2 to 7 m.

Seagrass and seaweed coverage was evaluated following the seagrass watch methodology (McKenzie *et al.*, 2003).

Human impact in the study area was evaluated calculating the proportion of boats, snorkelers and divers within the area, recorded as the number of sighted boats, snorkelers and divers divided by the total number of observation days per year.

**RESULTS**

The number of sightings from 2006 to 2011 varied from 8 to 128 (Table I).

Table I: Number of sightings per year.

| | **Number of sightings** |
|---|---|
| 2006 | 24 |
| 2007 | 44 |
| 2008 | 8 |
| 2009 | 22 |
| 2010 | 128 |
| 2011 | 57 |

In 2006, species type was not recorded, whereas during other years, the green turtle was the most sighted species (min1% in 2010 and max 68 % in 2007), with the exception of 2010 when a hawksbill was regularly observed in the area (93%) (Fig. 2).

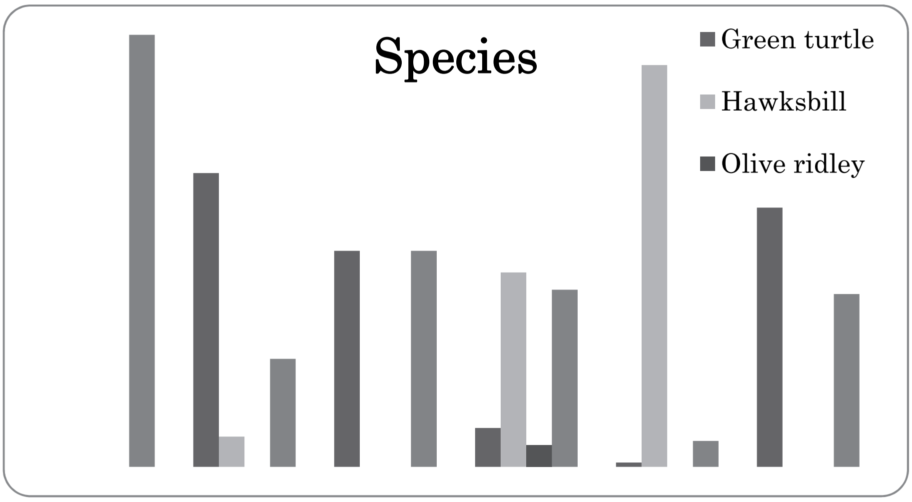


Fig. 2: Species occurrence per year (%) within the study area.

The number of emergences per sighting varied over the years, with a min of 2,2on average (N=18)in 2008 and a max of 7,2 (N=173) in 2006 (Table II).

Table II: Total number of emergences per year within the study area including different species.

| Year | Total | Average per sighting | Min – Max |
|---|---|---|---|
| 2006 | 173 | 7,2 | 1 – 19 |
| 2007 | 309 | 7,0 | 1- 33 |
| 2008 | 18 | 2,2 | 1-7 |
| 2009 | 80 | 3,6 | 1-11 |
| 2010 | 678 | 5,3 | 1-15 |
| 2011 | 174 | 3,0 | 1-15 |

With respect to the percentage of emergences, sector D with 57%, in 2007 was the most frequented, whereas in 2009 and 2010 sector P, with 29% and 73% respectively, was mostly used by turtles. In 2008, preference was shown for sector R with 39%and in 2011, emergences were equally distributed between sector N (15%), C (19%) and Q (11%).

From 2007 to 2011, the diving time for green turtles varied from 1 minute (min) to 97 minutes (max). The average varied from 1, 5 minutes in 2010 to7.4 minutes in 2009 (Table III).

Table III: Average diving time for the green turtle (*Cm*) and the hawksbill turtle (*Ei*) per year in minutes. N=total number of emergences. Min= minutes.

| | N | | Average (min) | | Min-Max (min) | |
|---|---|---|---|---|---|---|
| Year | *Cm* | *Ei* | *Cm* | *Ei* | *Cm* | *Ei* |
| 2007 | 249 | 29 | 5,1 | 6,6 | 1-97 | 1-45 |
| 2008 | 9 | na | 5,3 | na | 1-18 | na |
| 2009 | 11 | 42 | 7,4 | 7,3 | 1-24 | 1-15 |
| 2010 | 2 | 533 | 1,5 | 18,8 | 1-2 | 1-47 |
| 2011 | 83 | na | 4,5 | na | 1-34 | na |

The Hawksbill turtle diving time varied from 1 to 47 minutes between 2007 and 2011(Table III).The highest (on average) diving time was recorded in 2010, of 18,8minutes.

The underwater survey showed a substrate mix of rocks and sand, and an absence of seagrass. Species and genera of algae were identified as: *Dictyota,Galaxaura, Gracilaria, Halopteris vergatum, Halimeda, Hypnea, Laurencia, Litophyllum, Lobophora variegata, Neomeris, Padina, Sargassum, Turbinariaornata*.

The *Sargassum* covered a rock in sector D with a distribution that variedfrom 80 to 0%according to the seagrass percent cover standards (McKenzie *et al.*, 2003), in 2007 and 2008 accordingly. In 2008, Sargassum was only recorded near Sector R and it was about 50%. In 2009 it was at 3% within sectors B, F, L and P (Fig. 4).

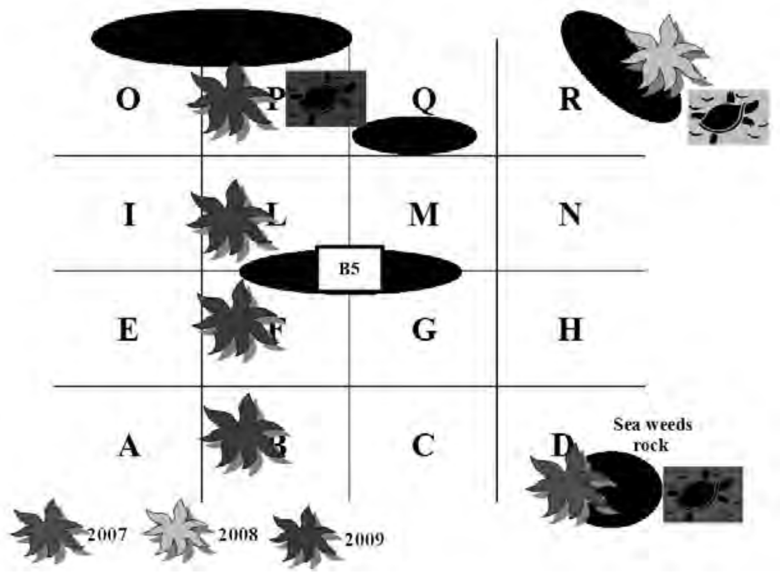


Fig. 4 : Distribution of *Sargassum* within the study area. *Sargassum*, is represented by the symbol- plant; each color indicates a year. The turtle symbol (in different colors according to the season) indicates the highest concentration of emergences in that sector.

From 2009 to 2011 the percentage of boats recorded within the area increased from 1% in 2009 to 10% in 2010 and to 20% in 2011. The presence of snorkelers and divers was mostly recorded in 2011 (Fig.5).

In 2006 a dead green turtle was found in a fishing cage (Aureggi, 2006)

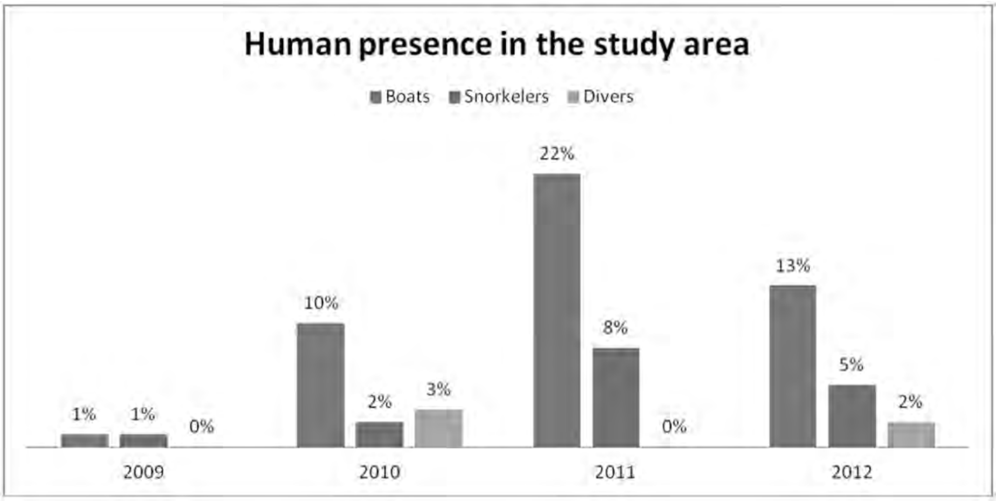


Fig. 5: Human presence (boats, snorkelers and divers) within the study area from 2009 to 2012.

**DISCUSSION**

Taking into account the fact that data was collected following a standard methodology, but with differences created by different observers over different time periods, the six years of observation revealed an even distribution in the number of sightings, with the exception of a low number (N=8) in 2008 and a high number (N=128) in 2010. The latter result is probably due to the presence of a single juvenile hawksbill in the area emerging regularly at the same spot.

The main species recognized was the green turtle, probably due to its dietary requirements. Young green turtles are believed to occupy open ocean pelagic habitats, perhaps in association with sargassum rafts in some areas, after leaving the nesting beach. It is assumed that they are omnivorous with a strong tendency to carnivory during this life stage (Bjorndal, 1985). Green turtles leave pelagic habitats and enter benthic foraging areas at a size of 20 to 25 cm carapace length in the western Atlantic (Bjorndal and Bolten, 1988) and at 35cm in Hawaii and Australia (Balazs, 1980; Limpus *et al.*, 1994). At that time they shift to a herbivorous diet and, as herbivores, occupy a feeding niche unique among sea turtles. Green turtles feed primarily on seagrasses and algae, although they also consume animal matter, particularly jellyfish, salps, and sponges (Bjorndal, 1997)

The diving time of the green turtle represents a similar dive pattern as the one described by Seminoff *et al*, 2006 in the Gulf of California where the diving time of 4.5 minutes at a mean depth between 1,3 and 7 meters is described as short and shallow dives called U-shaped dives. Even though we have not conducted direct observations underwater, it seems that the green turtle behavior, within this study area,is a combination of stationary benthic foraging and active foraging in the mid-water column.

The underwater survey revealed the presence of some seaweeds species (*Dictyota,Gracilaria, Hypnea, Laurencia, Lobophora variegata, Padina, Sargassum and Turbinaria ornata)* that are part of the green turtle diet in the Hawaiian Islands and has been found in the stomach content particularly when other food sources are not available(Gardner *et al*., 1999; Arthur and Balazs, 2008).

The minimum and maximum diving time of the hawksbill recorded in the study area were comparable with a study on a juvenile hawksbill in the Seychelles (Houghton *et al,* 2003) conducted on a reef plateau and a flat sandy area of max 10 m depth. In fact, in the Seychelles stationary and active foraging was recorded for 14,3 to 16,8 minutes (Houghton *et al*, 2003). The hawksbill at PTI was observed resting under a rock (Fig. 3) and its long diving time (1to 47 minutes), presumably an assisted rest; in the Seychelles resting was observed with a diving time of 21, 3 to 23,8 minutes(Houghton *et al*, 2003) .

Fig.3: A juvenile hawksbill turtle in an assisted resting state in the study area

The distribution of *Sargassum*in the area reflects the distribution of emergences (Fig.4).In 2007 and 2008 the highest concentration of emergences of green turtle occurred in sector D and R, with a diving time that suggested feeding behavior, presumably on the rock where *Sargassum* was recorded. On the other hand, in 2009 the highest number of emergences of hawksbill was in sector P, the place where the hawksbill was seen underwater while doing assisted resting.

Thus, the presence of *Sargassum*turtle food (Russel and Balazs, 2009) suggests that turtles were found in the area looking for food or feeding.

Being an unprotected area in the open sea and rich in underwater life, it is used by fishermen and for leisure activities such as diving and snorkeling.

It is known that boats passing near shore can increase the risk of turtle-vessel strike. In the Mediterranean, after fishing, the second most common cause of mortality was collisions with boats (Casale *et al*, 2010). The impact with the keel or propeller causes fractures to or cuts on the carapace, head or limbs. The importance of this mortality factor was previously reported from the Gulf of Naples, south Tyrrhenian, where boat strikes were responsible for 28% of live turtles admitted to a rescue centre (Bentivegna and Paglialonga, 1998). Boat strikes are recognized as a cause of mortality for several species not only in the Mediterranean (Panigada *et al.*, 2008) but also in other areas such as the north-west Atlantic (Lutcavage et al., 1997; Boulon, 2000). The present results suggest that with boat traffic increasing around Phra Thong Island, vessel strike could become a significant cause of mortality as well.

Another human impact commonly observed in the area is local and small-scale fishing, which includes the use of squid traps, the most common type of fishing gear, that can also potentially catch turtles (Fig. 6).The trap stays at sea overnight and can attract turtles (Tsaros and Aureggi, 2007). The opening (35-40 cm) could allow a young turtle to enter and become trapped. This opening should be reduced to minimize by-catchwithout reducing the amount of squid caught in trap.

In conclusion**,** the number of sightings, supported by behavioral observations of sea turtles and underwater surveys, suggest that this area is used as a turtle feeding area, which is important together with the seagrass meadows around PTI. As previously described, the area is frequented by both immature green and hawksbill turtles. The loss of this feeding area could have a negative effect on juvenile sea turtle populations, which represent the future nesting population. It is known that green turtles are able to modify their feeding behavior, looking for alternative algae food source (Arthur and Balazs, 2008; Bell & Ariel, 2011). Loss of usual feeding grounds and coastal habitat degradation on the availability of food source can result in green turtles moving to alternative sites and to a different diet. But the “new diet” is a long process. In fact because green turtles are gut-ferment digesters, they rely on a specific suite of gut flora (Bjorndal, 1991) and if they shift] from a diet of seagrass to one consisting of algae, they also need a shift in the microflora to digest the new diet and release the nutrients (Bjorndal, 1980). Some green turtle populations are well adapted to the algae diet but for those that have to find an alternative food source to seagrass and are not yet adapted to it, this can have bad consequences. In Australia green turtles are exhibiting signs of malnutrition (Bell and Ariel, 2011). The diet influences growth rate, and hinders their capability to reach maturity and reproduce (Balazs, 1982; Bjorndal, 1985).

The decline in abundance and quality of coral reef habitats affects the movement of hawksbills, which are usually characterized as inhabiting open-coast areas consisting of coral reefs and other hard-bottom substrates. Recently, however, in the Eastern Pacific, hawksbills have been recorded in mangroves estuaries. This variation in habitat use can be the result of adaptation (Gaos *et al*., 2011).

Marine Protected areas (MPAs) could prevent the decline of an area. They are designed to meet a variety of environmental and socioeconomic goals, including the protection of commercial and non-commercial marine species, the generation of tourism revenue, the conservation of critical habitats and ecosystem processes, and the creation of educational and research opportunities. MPA shave been established worldwide and in Thailand the network is growing.

On PTI local conservation actions have advanced during the years of Naucrates activities. Villagers are very motivated and keen to preserve their natural resources. In the last year, we have facilitated several conservation meetings. People from different villages came together to discuss their needs and worries about development on the island.

Two sea grass marine protected areas were established by the local Puyai at Tapyoi and Lion Village in 2011. It is a first step towards the conservation of the area. It still needs work and support towards correct sustainable management, but it a sign of local community interest in conservation.

The effort of Naucrates focuses on the conservation of sea turtle nesting populations, highlighting the importance of the nesting habitat located at PTI. This effort is now extended to conservation in the sea, highlighting the urgent need to designate a MPA. Conservation actions with the involvement of the local community are successful in the long term (Tsaros and Aureggi, 2007). Fishing restrictions and mitigation measures would help to conserve the local biodiversity. Strict regulations should be designed and implemented for the sustainable use of natural resources in the sea, by recreational sports and tourist activities, such as diving and snorkeling.

The use of floating signs can mark and delineate the area to ensure it is avoided by passing boats and fisherman putting down their cages, and to make divers and snorkelers aware of the area in which they are swimming.

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